METHOD AND SYSTEM FOR DESIGNING A BUILDING

FIELD OF THE INVENTION

This invention relates to methods for designing a building.

BACKGROUND OF THE INVENTION

A modern building contains several distribution systems for channeling gases, liquids and electricity throughout the building. Such distribution systems include a plumbing system, electrical system, and heating and air conditioning systems. Each distribution system consists of one or more elements. For example, elements in a plumbing system may include pipes of a particular diameter, faucets, drains, etc.

Governmental bodies have legislated building codes that establish standards that a delivery system must comply with. Insurance companies as well as the building industry itself may require compliance with standards that are more stringent than the relevant government codes. U.S. Patent No. 4,964,060 to Hartsog discloses a computer-aided building plan review system for determining from a building plan whether a delivery system complies with applicable standards. A building plan is input into a processor that compares a delivery system included in the plan with relevant standards stored in a memory.

In addition to building codes regulating a particular delivery system, codes may also exist regulating inter-relationships between two systems. A code may stipulate a minimum distance between an element in one system and any element in another system. For example, a code may specify a minimum distance between electrical wires and water pipes in a building. Generally, an architect or a general contractor designs the building elements (beams, walls, joists, etc.) Spaces are

allocated in the building design for receiving the various delivery systems. The architect, however, does not specify how the various delivery systems are to be arranged within the spaces. It is thus left to the sub-contractor of each system to install his system within these spaces. This may lead to a haphazard arrangement of the systems in the spaces, determined by the order in which the systems are installed, and how each subcontractor deals with facts already created in the spaces by the systems previously installed. This limits the ability of a sub-contractor to completely plan the system prior to its installation because logistical problems arise which can only be solved at the time of installation. The need for on-site designing of the system increases the time required for the installation and the amount of materials that must be allocated for the installation. Moreover, the final arrangement of the systems in the spaces may not comply with building codes regulating spatial relationships between the various systems in the building.

SUMMARY OF THE INVENTION

The present invention provides a method and system for arranging delivery systems in a building during the design stage of the building so that building standards specifying spatial relationships between any pair of systems are complied with.

In accordance with the invention, a development plan is provided for each system. The development plan is typically provided by the sub-contractor who is to install the system in the building. The development plan shows the installation of the system in the spaces allocated for the system by the architect or main contractor. The development plans are input to a data processing system. A memory included in the processing system contains data indicative of building standards where each standard is applicable to a pair of delivery systems. For each pair of delivery systems, a standard specifies a first distance that is the minimal allowable distance that must exist between any element of the first system and any element of the second system. An arrangement of the two systems in which the distance between an element of one of the systems and an element of the other system is less than the

first distance is unacceptable. The standard may also specify a second distance that is greater than the first distance. In this case, a distance between an element of one of the systems and an element of the second system is greater than the first distance but less than a second is allowable, however, it is preferable that the minimal distance between the two elements be greater than the second distance. The memory also stores a control program that generates a composite developmental plan from any two input developmental plans. The composite plan presents the two systems as they would appear if each system were to be installed according to its developmental plan. The control program also evaluates a composite plan according the standard applicable to the pair of systems in the composite. A processor receives from the memory two input development plans as well as the applicable standard and runs the control program. An output means such as a CRT or printer is connected to the processor to display the composite plan and the evaluation of the plan produced by the control program. The output of the evaluation may consist of indicating for each pair of elements, one element from each system, whether the distance between the two elements is below the first distance, and hence not allowable. If a second distance has been specified, the evaluation may consist of indicating whether the distance between the two elements is between the first and second distances (hence allowable but not desirable) or above the second distance.

If the evaluation of a composite plan shows that the distance between an element in the first system and an element of the second system is below the first distance, or between the first and second distances, a user may then alter the arrangement of elements in the original developmental plan, of one or both of the systems in order to bring the two systems into conformity with the standard. Moving an element of a system in the composite plan is most conveniently accomplished using a computer mouse and drag and drop technology. The new arrangement of the two delivery systems is then evaluated according to the applicable standard. The process of moving a component in the composite and evaluating the modified composite may be repeated as many times as necessary

until an arrangement of each of the systems is found so that the pair of systems complies with the applicable standards.

A hierarchy may be established to determine the order in which pairs of systems are evaluated by the control program. The first and second systems in the hierarchy are first evaluated, and if necessary, one or both of the systems are rectified in order to bring the pair of systems into conformity with the applicable standard. The third system in the hierarchy would then be evaluated with the first system and separately with the second system. If necessary, any one of the first three systems are then rectified to bring each possible pair from among the three systems into conformity with the applicable standard. The process continues with at each stage evaluating the next system in the hierarchy with each of the systems before it in the hierarchy and rectifying any of these systems in order to bring each pair of these systems into conformity with the standard.

The invention comprises a method for evaluating a composite developmental plan, the composite plan being indicative of a simultaneous arrangement of a first delivery system and a second delivery system in a building, the first and second delivery systems being composed of elements, the method comprising steps of:

(a) providing a standard, the standard specifying a first distance; and

(b) for each pair of a first element present in the first system and a second element present in the second system, determining whether the distance between first and second elements in the composite plan, is greater than the first distance.

The invention further comprises a method for arranging n delivery systems in a building, the method comprising the steps of:

(a) providing a developmental plan for each of the n systems ;

(b) arranging the systems in a hierarchy, S_1……., S_k…., S_n, where S_k is the k-th system in the hierarchy;

(c) for k = 2, ……n

(ca) for i=l, …….k-1;

(caa) providing a composite developmental plan of system S_k and system S_i,

(cab) evaluating the composite plan by the method of the invention.

The invention still further comprises a method for arranging n delivery systems in a building, the method comprising the steps of:

(a) providing a developmental plan for each of the *n* systems ;

(b) arranging the systems in a hierarchy, $S_1,..S_k,...S_n$, where S_k is the k-th system in the hierarchy;

(c) for k = 2, ...*n*

(ca) for i=l, ...k-1;

(caa) providing a composite developmental plan of system S_k and system S_i.

(cab) evaluating the composite plan by the method of the invention.

The invention still further comprises a system for evaluating a composite developmental plan, the composite plan being indicative of a simultaneous arrangement of a first delivery system and a second delivery system in a building, the first and second delivery systems being composed of elements, the system comprising a processor configured to determine, for each pair of a first element present in the first system and a second element present in the second system, whether the distance between the first and second elements in the composite plan is greater than a first predetermined distance.

The invention still further comprises a system for arranging a delivery system in a building, each system having a developmental plan, the systems being arranged in a hierarchy $S_1...S_k...S_n$, where S_k is the k-th system in the hierarchy, the system comprising a processor configured to:

for k=2,..., n

for i=1, ...k-1

(a)producing a composite plan of the developmental plans of S_i and S_k

(b) for each pair of a first element present in the i-th system and a second element present in the k-th system, determining whether the distance

between the first and second elements in the composite plan is below a first predetermined distance A_{i-k}.

The invention still further comprises a system for arranging a delivery system in a building, each system having a developmental plan, the systems being arranged in a hierarchy $S_1 \ldots S_k \ldots S_n$, where S_k is the k-th system in the hierarchy, the system comprising a processor configured to:

for k=2,…, n

for i=1, …k-1

(a)producing a composite plan of the developmental plans of S_i and S_k

(b) for each pair of a first element present in the i-th system and a second element present in the k-th system, determining whether the distance between the first and second elements in the composite plan is below a second predetermined distance A_{i-k}.

The invention still further comprises a program storage device readable by machine, tangibly embodying a program of instructions executable by the machine to perform method steps for assessing two or more developmental plans, each developmental plan being indicative of an arrangement of a delivery system in a building, the method comprising steps of:

(i) producing a composite developmental plan, the composite plan being indicative of spatial relationships among the delivery systems in the building;

(ii) determining whether the composite plan complies with one or more building standards.

The invention still further comprises a computer program product comprising a computer useable medium having computer readable program code embodied therein for assessing two or more developmental plans, each developmental plan being indicative of an arrangement of a delivery system in a building, the computer program product comprising:

computer readable program code for causing the computer to produce a composite developmental plan, the composite plan being indicative of spatial relationships among the delivery systems in the building;

computer readable program code for causing the computer to determine whether the composite plan complies with one or more building standards.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, a preferred embodiment will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1 shows a system for designing a building according to one embodiment of the invention;

Fig. 2a shows a flow chart diagram for carrying out the method of the invention and **Fig. 2b** shows screens displayed to the user at various stages of the method;

Fig. 3a shows a flow chart diagram for carrying out the generate composite option, and **Fig. 3b** shows screens presented to the user at various steps of the method.

Fig. 4a shows a flow chart diagram for executing the process composite plan option, and **Fig. 4b** shows screens displayed to the user on at various stages of this option.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 shows a system for evaluating pairs of development plans in accordance with one embodiment of the invention. A scanner **107** scans developmental plans **105** and stores the scanning data in a memory **110** of a processor **115**. The processor **115** may optionally convert any of the input

developmental plans **105** into a predetermined format. This eases comparison of the plans **105**. The processor **115** may call up scanning data from the memory **110** obtained from a plan and display plan **105** on a CRT **118** in either a two- or three-dimensional view. A memory **120** contains a composite plan generating program that generates a composite of two or more developmental plans **105**. The memory **120** also contains files storing data indicative of standards **125** applicable to pairs of delivery systems. A standard applicable to a particular pair of systems specifies a first distance that is the minimal distance that must exist between any element from one of the two systems and any element from the other system. The standard may optionally specify a second distance that is greater than the first distance. The distance between an element of one of the systems and an element of the other system may be between the first and second distances, but it is preferable that the distance between them be greater than the second distance. The memory **120** also contains files storing a plan check program **130** that evaluates data indicative of composite plan against the standard applicable to the two systems shown in the composite. A processor **135** receives scanning data of two plans **105** and generates a composite of the plans using the composite generating program. The composite plan may be stored in the memory **110** and may be displayed on the CRT **118**. The processor **135** then checks the composite plan against the applicable standard to the two systems using the plan check program. If in the composite plan, the distance between an element of one of the systems and an element of the second system is less than the first distance or is between the first and second distances as revealed by the plan check program. this is indicated by the check program on the CRT.

Fig. 2a shows a flow chart diagram for carrying out the method of the invention and Fig. 2b shows a screen **300** displayed to the user on the CRT **118** at various stages of the method.

In step **200**, the screen **300** is displayed showing an introductory menu. The menu presents a set of options for performing the various tasks executable by the program. One option is a tutorial **301** that allows the user to obtain an explanation

of the operation of the software package. A second option is inputting standards applicable to pairs of delivery systems **302**. The user may also opt for scanning a developmental plan **303**, or in the event that a plan is provided by a sub-contractor in a data storage device such as a computer disk, inputting the data to the memory **304**. Other options include generating a composite plan of two or more plans **305** or processing a composite plan **306**.

In step **205** the user selects an option from among the options presented to him on the options screen **300**. This is done by the user bringing a cursor to one of the buttons representing an option using a computer input device such as a computer mouse and clicking the mouse. In step **210** the selected option is run.

Fig. 3a shows a flow chart diagram for carrying out the generate composite option **305**, and Fig. 3b shows screens presented on the CRT **118** to the user at various steps of the method. In step **310**, a plan menu **350** is displayed. The plan menu **350** presents a list of systems whose developmental plan is stored in the memory. The systems include, for example, the water system **355**, the electrical system **360**, the heating system **365** and the air conditioning system **370**.

In step **320**, the user selects two systems from among the systems appearing in the plan menu **350**. A system is selected by the user bringing the cursor **307** to the system and clicking the mouse. After the two systems have been selected, the user presses the run button **375** (step **325**) in order to run the composite plan generating program. In step **330**, the generated composite plan **380** is displayed on the CRT as shown in the screen **385**. In this example, screen **380** shows a composite plan of a plumbing system (comprising a pipe **381**), and an electrical plan (showing electrical wires **382, 383, 384**). The user is then prompted in step **335** whether to store the composite plan **380** in the memory. The user makes his selection by clicking the appropriate button (yes **386** or no **387**).

If the user clicks the yes button, (step **340**), a screen **390** appears on the CRT **118** prompting the user to input a title for the composite plan in a field **392**. The user does this using his computer keyboard and then presses the enter button **394**.

The option screen **300** is then displayed on the CRT (step **345**). If the user clicks the no button in step **335**, the option screen is then displayed on the CRT (step **345**).

Fig. 4a shows a flow chart diagram for executing the process composite plan option **306**, and Fig. 4b shows screens displayed to the user on the CRT **118** at various stages of this option. In step **400** the composite menu **450** is displayed on the CRT. The composite menu **450** displays a list of all composite plans stored in the memory. The user then selects from among the displayed composite plans the plan to be analyzed by the composite check program (step **410**) by pressing the appropriate button **455** on the composite screen **450**. The composite check program then runs (step **415**), and the results of the program are displayed on the CRT (step **420**).

The results are displayed by means of a screen **460** displayed on the CRT **118** showing the composite plan in which elements or pairs of elements that fail to comply with a standard are highlighted. For example, in screen **460**, the distance between the water pipe **381** and the electric wire **382** is below the first distance as specified by the standard applicable to a plumbing system and an electrical system. This is indicated by an arrow **461**. The distance between water pipe **381** and electric wire **382** is between the first and second distances specified by the standard. This is indicated by a broken arrow **462**. In step **425** the user is prompted to decide whether to amend any of the systems appearing in the composite. If yes, the user is prompted to select an element of a system appearing in the screen **460** (step **430**). The user selects an element with his computer mouse and drags it to a new location in the composite plan (step **435**). For example, the user may decide to move the electrical wire **382** away from the water pipe **381,** so that the composite plan appears as a distance between that shown in screen **465.** The distance between the electrical wire **382** and the water pipe **381** in screen **465** is greater than the second distance specified by the applicable standard. The arrow **461** has therefore disappeared and has not been replaced with another arrow. The user is then asked whether he wishes to move another element in the composite

plan (step **440**). If yes, the process returns to step **430** with the selection of a new element. If no, the process returns to step **415** with execution of the composite check program applied to the amended composite plan. If at step **425** the user decides not to further amend the composite, the amended composite plan is stored in the memory.

It will also be understood that the system according to the invention may be a suitably programmed computer. Likewise, the invention contemplates a computer program being readable by a computer for executing the method of the invention. The invention further contemplates a machine-readable memory tangibly embodying a program of instructions executable by the machine for executing the method of the invention.